CHAPTER 5. ACADEMIC R&D

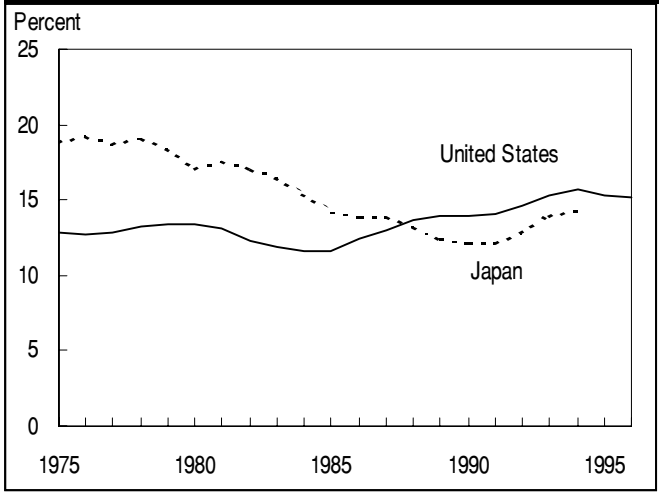
The problems of Japanese universities, as well as their proposed solutions, have been widely noted and discussed.[22] Solutions revolve around ways to increase the quality of research performed in universities: providing competitive funding to university professors and more financial support to graduate students, and improving facilities and equipment in graduate departments. The Science and Technology Basic Plan especially focuses on removing the barriers to high-quality basic research in universities and national laboratories. The Japanese government plans to systematically improve the research facilities and instrumentation of national universities, and also the computer networks among R&D institutions. With these changes, their conduct of science will resemble more closely that of the United States: more government funding of basic research, more competitive research grants, more centers of excellence in universities, and expanded graduate programs, postdoctorate fellowships, and research assistantships.

The Japanese government also plans to promote and fund joint research between industry, university, and government laboratories. Government laboratories will hire additional S&E personnel on fixed-term appointments and, based on expected reforms in the National Personnel Authority, there will be more flexibility for universities in hiring faculty and researchers. Monbusho is planning to submit a bill to introduce a limited tenure system at the nation's colleges and universities during an ordinary Diet session early in 1997.

ACADEMIC R&D TRENDS

The decade-long trend, observed from 1980–91, toward a diminishing role for academic performers in total Japanese research and development, ended in 1992. During that period, academic performance decreased from a 17-percent share to a 12-percent share of total Japanese R&D performance (figure 26).

Figure 26. Higher education R&D expenditures as a share of total R&D



See appendix tables A-2 and A-5.

As a result of strong support provided by the government's 1993 and 1994 budgets, Japan's academic performance rose to a 14-percent share of total Japanese R&D. Although this is partly due to a decline in industrial research, it is also due to the large government budgets (with supplemental budgets in 1993, 1995, and 1996), which began the process of strengthening basic science in Japanese universities. It is expected that the previous diminishing trend will reverse, and that academic R&D will continue to increase as a share of the national performance total in the next several years.

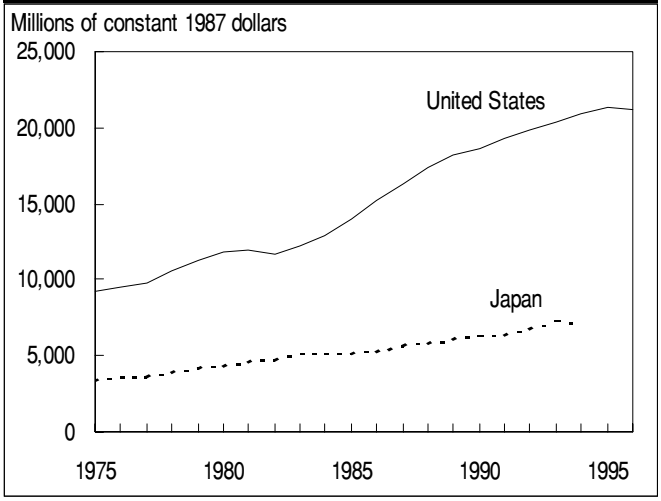
Approximately 30 Japanese universities are strong in scientific research, as well as education (Arima, 1992). There are 63 attached research institutes within these universities, 18 of them for joint use. In the 1970s, Monbusho began building National Inter-University Research Institutes that are open to all university researchers. They provide large-scale, well-equipped research facilities that also serve for international collaboration in specific fields. The first of these inter-university research institutes was the National Laboratory for Higher Energy Physics, KEK. These institutes, now numbering 15, have the same status as national universities. The Graduate University for Advanced Studies (GUAS), established in 1988, is also for graduate students working in these same institutes (Monbusho, 1995).

[22] See, for example, the Japanese National University Association "Basic Research on University Operations," 1992, which surveyed all national university professors on their research environment and made recommendations to Monbusho on how to improve the present status. American Association for the Advancement of Science (AAAS). 1992. *Science in Japan. Science* 258, 23 October. Special issue on Japan.

While research flourished in the 1970s, the government's deep cuts in university construction budgets and general funds for basic research in the 1980s seriously affected Japanese universities' ability to do research. The retrenchment of government research in the 1980s forced universities to look to industry for donations and small additional sources of support. Until multiple funding sources became possible in 1995, the funding of these national universities had been centralized through Monbusho. Professors are civil servants and all faculty (both senior and junior) are tenured for life.

Based on several science advisory reports such as that conducted by the Japanese National University Association (see "*Japan's University Survey*"), an important Cabinet document formulated a science policy that recognized the importance of basic research for Japan and proposed improvements in research conditions. The 1992 S&T policy document included a major renewal of facilities and equipment for universities and national research institutes, and expanded competitive research grants. The Japanese government made large supplemental budgets to Monbusho in 1993 and 1995 to begin to address these recommendations. The latest available data on R&D expenditures in the higher education sector show academic R&D reached approximately $7 billion in 1994. In that same year, U.S. academic research reached $21 billion (figure 27).

Figure 27. R&D expenditures in the higher education sector



See appendix table A-5.

The distribution of higher education R&D expenditures by field differs across countries. Japanese priorities for academic research in 1993, as indicated by dollar amounts of research funded, were medicine, social sciences, and engineering, in that order. In contrast, in the United States, academic research is focused on the natural sciences. Research in fields of natural sciences reached 35 percent of overall U.S. university research in 1993, an amount that is almost equal to that performed in both medicine and engineering combined (figure 28).

Academic research in public universities is primarily supported by formula funding, but mechanisms for industry—university cooperative research were introduced in the 1980s. Funds for scientific research are provided by Monbusho to university "chairs" based on the number of researchers and graduate students. In addition, in 1983 Monbusho allowed university professors to participate in industry—university projects (ERATO) funded by the Science and Technology Agency (STA). Under ERATO, a new facility is established with 5-year funding for joint projects by industry and university professors. ERATO differs from the U.S. National Science Foundation's S&T Centers in that professors under ERATO funding are hired away from their university, and project equipment does not build on their current university laboratory.

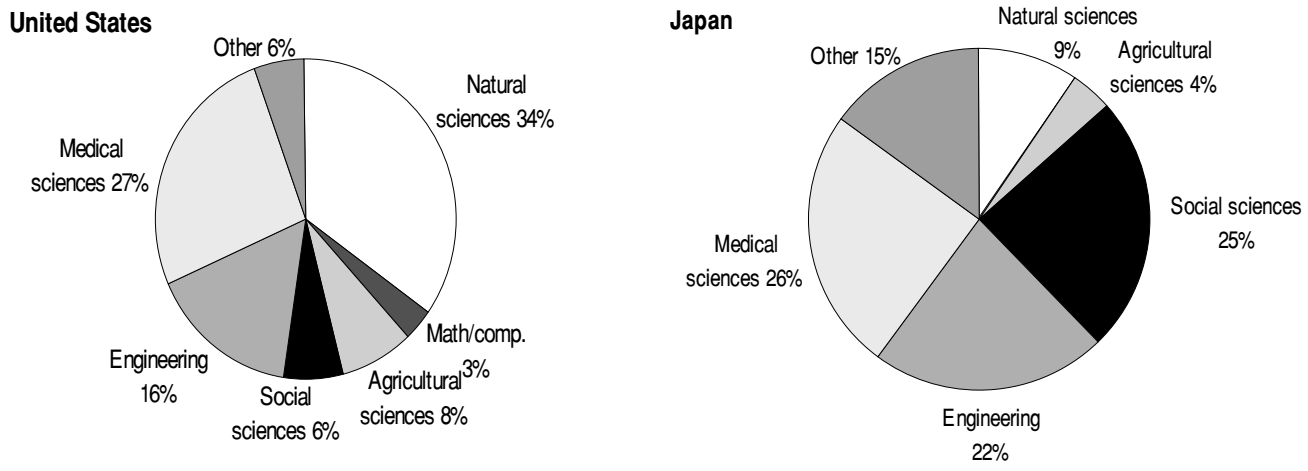
In the 1990s, Japan's university research funding is increasing through Monbusho's additional funding of grants-in-aid and from a trend toward multi-channel funding. After 1995, government agencies other than Monbusho can contribute directly to academic science. Monbusho has recently written legislation to allow direct funding of university researchers by STA and MITI. Monbusho also increased funding for competitive research to 100 billion yen in 1996 (approximately $450 million dollars) (Monbusho, 1996). These research funds are provided to individual researchers on the merit of their proposals through Monbusho's Grants-in-Aid Division.[23] Considering sources of funding from various science agencies, competitive research support reached almost $875 million (in constant 1987 million dollars) at national universities by 1995 (table 6). The overlapping funding of universities by other government agencies (STA and MITI), which is now permitted, provided one-quarter of a million dollars to national university research funding in that same year; industry almost $200 million dollars.

[23] See NSF Tokyo Report 95-18 (NSF, 1995a).

JAPAN'S UNIVERSITY SURVEY

In 1992, the Japanese National University Association conducted a survey of all national university professors regarding university operations and their research environment. The survey included items on their salary, equipment, space, barriers to the pursuit of research, teaching hours, travel and research grant funds, and any cooperative activity with industry. The survey also solicited their opinion of the quality of their research, whether funds other than Monbusho would be good for national universities, whether shared use was possible for their equipment needs, and how to improve the present status of university research. Of the respondents from national universities, 60 percent considered their conditions "very much inferior" to those in the industrial sector (Koizumi,1993). The results were summarized and recommendations were made to Monbusho to improve research equipment and its efficient use by opening facilities to other universities, to increase the budget for research grants and travel, to introduce funds from other organizations into the university, and to strengthen its linkages with other ministries (STA and MITI) involved in funding Japanese science.

Figure 28. Distribution of higher education expenditures, by field: 1993



See appendix table A-22.

The majority of university research funding, however, still comes from Monbusho's formula funding of university chairs.

These three ministries (Monbusho, STA, and MITI) also came together to provide multiple funding sources for the creation of university Centers of Excellence (COE). (See NSF Tokyo Report 95-22 for background on Monbusho and STA programs for COE, NSF, 1995b). The objectives of these centers are to be the focal point of information in a particular field, set a research direction that is leading the field, and have a significant output of research articles in that field. While Japanese industry will continue to use U.S. graduate schools for advanced training of their researchers, Japanese industry will likely expand their collaboration with Japanese universities' emerging centers of excellence.

In 1996, Monbusho has provided JSPS with new competitive research funds for all universities. Similarly, STA initiated new programs in 1995 to which

researchers in universities and national laboratories affiliated with STA may apply. MITI has done the same. The problem of lack of technicians in university research laboratories is addressed in these new funding schemes, which allow hiring of needed technicians for a fixed-time research project.

Government Financing of Research Facilities

Japan's government is supporting cutting-edge facilities under Monbusho and STA funding, and is a contributing member of CERN for international cost-sharing. (AAAS, 1997). The major focus is on renovation of existing facilities and on new national inter-university research institutes that allow shared-use by several universities. Monbusho's support of new world class facilities and "big science" allows for the expansion of basic science in the fields of astronomy, high-energy physics, space science, environmental earth, and bioscience. (See *"Japan's Unique Scientific Facilities"* on increased opportunities for access by the international research community to these unique scientific facilities.)

Japan's Unique Scientific Facilities

Japanese government agencies (STA and Monbusho) have growing science budgets to provide a boost to the funding and realization of world class research facilities, such as The International Thermonuclear Experimental Reactor (ITER). The goal of this facility, funded by the Russian Federation, Europe, the United States, and Japan, is to demonstrate controlled ignition of plasmas and, ultimately, the utilization of fusion power for practical purposes. Japanese funding is especially encouraging because of tight European and U.S. science budgets for international facilities. For example, Japan's 1997 government budget authorized $32 million for their role in planning the Large Hadron Collider (LHC) at CERN in Switzerland (AAAS, 1997). In addition, Japan's recently launched MUSES-B satellite will provide radio astronomers the first space-based antenna dedicated to very long baseline interferometry (Normile, 1997); multinational collaborators will take the radio-astronomical observations. Japan's proposed facility in radio astronomy, called Large Millimeter and Submillimeter Array, is expected to provide one of the dominant facilities in millimeter-wave astronomy for the first quarter of the next century (Mervis, 1997).

Japan's increased government science budget will also contribute to large international research projects, such as the Ocean Drilling Program (ODP) and the continuation of the Human Frontier Science Program, providing funding to U.S. and European researchers. Japan has the first full-scale neutrino astrophysical observatory in the world, with 30 American collaborators. The SPring 8 synchrotron radiation facility under construction in Kobe will be completed in 1998 and open to overseas researchers.

Astronomical research will be strengthened through the Nobyeama Cosmic Radio Observatory and the Subaru facility in Hawaii, providing the largest single-mirror optical telescope (an 8-meter diameter optical and infrared telescope), open to the world's research community. Monbusho's support of the so-called "Super-Kamiokande" facility at the Institute for Cosmic Ray Research of the University of Tokyo, will allow unique solar and atmospheric neutrino experiments. Accelerator research will benefit from a new particle accelerator facility, called the KEK B-Project, will explore asymmetrical behavior among particles and antiparticles. The National Institute for Fusion Science will complete the Large Helical Device Facility to study steady-state plasmas leading to a fusion reactor (AAAS, 1997).